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June 1994

DCIEM No. 94-30

SEMI-ANNUAL PROJECT REVIEW

of the

EXPERIMENTAL DIVING UNIT

Nov 1993 to Apr 1994

Compiled and Edited

by

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468/94-27993



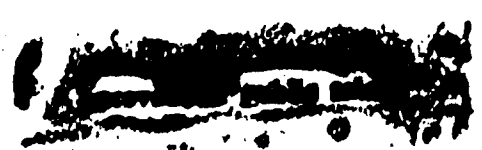
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Preface

The Experimental Diving Unit (EDU) produced this review for the Diving Task Review Meeting held at the Defence and Civil Institute of Environmental Medicine (DCIEM) from 9 to 12 May 1994. Twelve projects are included. Seven of these are tasks from National Defence Headquarters (NDHQ). The remainder of the projects come under DCIEM's Diving Systems/R&D Project, 51CD. The report covers work done from November 1993 to April 1994, inclusive. Previous work on these projects was reported in DCIEM report No. 93-56.

Two projects in EDU, development of a freeze-proof regulator and decompression tables for the Canadian Underwater Mine-countermeasures Apparatus (CUMA), continue to occupy the majority of the unit's time. Regulator development involved iterative testing and modification of two prototypes while two, four-week dive series were completed to add 173 more human exposures to the data base required to validate the CUMA decompression model and tables.

The development of an integrated system of equipment for mine-countermeasures diving integrated well with the CUMA decompression table validation. During each dive series components, such as new weight harness prototypes or dry suit samples, were included in the dives so that development could continue in parallel with the table validation. Another project which dovetailed well with the CUMA decompression work was the development of the hand heating system under the Clearance Diver's Supplementary Heater project. Prototypes were evaluated during the CUMA decompression dives. This project has expanded to include whole body heating and electric suits for this purpose were obtained to compare their performance against the standard hot water suit.

In other NDHQ sponsored tasks, the examination of lithium hydroxide as a carbon dioxide absorbent in the Submersible Diver Lockout (SDL) led to a recommendation to discontinue its use in favour of traditional soda lime. A field trial of various dry suits provided the necessary data to formulate a suit specification for use in self-contained diving in low level contaminated water. The study of the effect of the complement enzyme system on decompression sickness began with initial literature review and the training of a technologist to perform blood assay work.

Projects coming under DCIEM 51CD tested the hypothesis that exercise during the decompression phase of a dive can reduce decompression stress through a series of 129 human exposures. Work and meetings of the researchers developing a common model for decompression with helium/oxygen breathing mixtures progressed the establishment of a master data base to use for model development and validation. EDU staff built and field-tested prototypes of equipment needed to standardize surface-supplied diving communications systems. Quality assurance of soda lime for diving apparatus continued to involve international attention as a Study report was tabled at the NATO Underwater Diving Working Party Study. The investigation of thermometal neoprene concluded with a DCIEM report and final contact with the manufacturer to identify the varieties of materials

available.

he coming six months, work will conclude on the SDL carbon dioxide absorbent, sea contained, contaminated water diving ensemble and surface-supplied diving communications standardization. This will increase resources available for other projects such as the mine-countermeasures diving system development and clearance diver's supplementary heating. Another new project involving the investigation of closed-circuit rebreather diving apparatus is also expected to commence during the next review period.

David Eaton, M.Sc., P.Eng.

Head

Diving R&D Group

LCdr. Scott McDougall

Officer Commanding

Experimental Diving Unit

CF Freeze-proof Regulator Development

Project Scientist:	D. Eaton
Project Officer:	Lt(N) J. Frew
Start Date:	May 1992
Finish Date:	Mar 1996
Code:	DPAS 01141
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

Cold air and water temperatures cause problems with present CF single-hose CABA regulators. The cold produces ice on and in the regulators, especially in the second stage, causing them to malfunction. Malfunctions can also occur when the cold temperatures exceed material specifications. The most common symptom of the malfunctions, collectively termed as freeze-ups, is a violent free-flow of gas from the regulator. The free-flow could force the diver to ascend uncontrollably and result in a fatal air embolism. The less common problem occurs when the freeze-up closes the demand valve. The loss of gas could obviously lead to death.

Defence Relevance

The danger of freeze-up for divers, especially inexperienced ones, has been described as the most serious problem facing MARCOM diving operations. The consequences of a freeze-up have the potential to cause a fatality. A new regulator should be freeze-proof but it should also optimize breathing gas flow and breathing comfort to improve overall diver performance and safety.

Project Description

NDHQ let contract W8477-1-BB24/01/SV to Fullerton, Sherwood Engineering Limited (FSEL) to produce a freeze-proof CABA regulator. DMEE4-4 acts as Scientific Authority while EDU provides technical and testing support for the regulator development.

The contract with FSEL consists of a number of tasks. EDU participated in the first task to develop specifications for the regulator. Subsequent tasks involve development by FSEL followed by test and evaluation and recommendations for improvement by EDU.

In a parallel research programme, EDU determined the energy needed to keep regulator temperatures above freezing and is developing techniques to study regulator gas flow

dynamics to improve breathing resistance and regulator stability. DCIEM will develop the mathematical models and computer simulation software as funds become available for experienced computer programmers.

PROGRESS

EDU continued testing on a number of prototypes produced by FSEL. One configuration was chosen for further development. FSEL made incremental changes and the influence on breathing characteristics and freeze-up resistance were determined through tests done by EDU. After a number of design and test iterations it was decided to test the regulator's ability to meet the contract specifications.

The testing showed the current prototype met the requirements for work of breathing and maximum mouth pressures but did not meet demand valve opening pressure specifications. The prototype regulator also resisted freeze-up at 3 fsw and in certain orientations at 180 fsw; however, other orientations produced freeze-ups. FSEL is now considering other modifications to prevent freeze-up.

Productivity

Reports.

1. Technical Memorandum HPS 94-09, dated 18 April 1994

PROJECTIONS

FSEL will continue the development of the second stage to improve the demand valve opening pressure and the freeze-up resistance. EDU will retest any new prototypes. Once the specifications are met, EDU will conduct an evaluation with human subjects and commence arrangements for a field trial. Formal acceptance of the task (see Task Description Sheet below) is expected and EDU will use the funds to start upgrading the Unmanned Test Facility with a 4500 psig gas supply system. Modelling and computer simulation work is expected to continue as funds become available through the task and through co-operative research with the Aerospace Group.

2. GROUP TASK NO.

TASK DESCRIPTION SHEET

18. DRE Planning Code

01141-

1. TITLE: CF FREEZE-PROOF REGULATOR DEVELOPMENT

3. REVISION NO:

4. PROJECT SPONSOR: DGMEM/DMEE

5. PROJECT OFFICER: MR. R. Coren DMEE 4-4

6. PROJECT DIRECTOR: LCDR D. Kirby DNR 7-3

7. REFERENCES: DND CONTRACT W8477-1-BB24

8. DEVELOPMENT PROJECT NO: 01141

9. REQUIREMENTS DIRECTORATE: DNR 7

10. OTHER INTERESTED DIRECTORATES: D Div S

19. DND RESEARCH ESTABLISHMENT: DCIEM

20. PROJECT SCIENTIST: David Eaton, MSc, P.Eng

21. WORK PLAN: 1. Technical Specification Development 2. Review Task 2 report of possible solutions for second stage. 3. Test second stage models. 4. Review design drawings of second stage model. 5. Test and report for second stage working model. Re-test and report as required. 6. Manual evaluation, report, re-test and report as required. 7. Arrange and conduct field trial. 8. Assist in preparation of post field trial(s) report. 9. Review first stage model design drawings 10. Test first stage models. Report and re-test and report as required. 11. Conduct tests of integrated regulator. Report and re-test and report as required. 12. Arrange and conduct field trial. 13. Re-test and report as required. 14. Review connections field trial report. 15. Review summary report, design drawings, and cost estimates

22. SCHEDULE:

1. Oct 92; 2. Jan 93; 3. Apr 93; 4. Jul 93; 5. May 94; 6. Aug 94; 7. Nov 94; 8. Dec 94; 9. Jan 95; 10. May 95; 11. Sep 95; 12. Nov 95; 13. Dec 95; 14. Jan 96; 15. Feb 96.

11. BACKGROUND: The primary problem for CF diving is regulator freeze-up. Private industry has not produced a regulator that can withstand cold water conditions; therefore, NDHQ is managing a contract to produce a freeze-proof regulator. EDU has researched this area and will provide technical, research and evaluation support for the project.

12. AIM: To assist the development of a freeze-proof CABA regulator by studying energy and gas flow relationships in regulators and transferring this information to the contractor and to test contractor's prototypes.

13. SECURITY CLASSIFICATION: UNCLASSIFIED

14. RESOURCES SUPPLIED BY SPONSOR: Development funds identified within CRAD DPAS 01141 for FY93/94 through FY95/96.

15. REQUESTED START DATE: 1 Sep 92

16. COMPLETION ACTION: A. Review of contractor's reports on regulator development and tests.

B. Test and evaluation of contractor's regulators.

C. Review of contractor's drawings and final report.

17. SPONSOR'S SIGNATURE:

28. CRAD SIGNATURE:

23. REPORTING PLANS: Evaluation reports at the end of 5, 6, 10, 11, 13, 14. Final report at end of 15.

24. ESTIMATE OF EFFORT AND COSTS:

FISCAL YEAR	93/94	94/95	95/96
PERSON YEARS	0.3	0.3	0.3
PROF	0.4	0.5	0.3
TECH	0.1	0.5	0.5
MIL			
GOODS, SERVICES AND EQUIPMENT COSTS			
ESTABLISHMENT COSTS			
DND DEVELOPMENT FUNDS	0K	60K	40K

25. ESTIMATED START DATE: 01 Sep 92

26. ESTIMATED COMPLETION DATE: Mar 96

27. DCIEM SIGNATURE: M. W. Radomski, Chief DATE:

CUMA HeO2 Decompression Table Development

Project Scientist:	Mr. R.Y. Nishi
Project Officer:	Lt (RN) J. Cox
Project Engineer:	Mr. D.J. Eaton
Start Date:	1 Apr 91
Finish Date:	1996
Code:	DMEE 54, DPAS 011ZV-11
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

The Canadian Underwater Minecountermeasures Apparatus (CUMA/SIVA+) is in production for the CF and is due to enter service with Fleet Diving Units. The set mixes pure oxygen and pure helium gases to ensure a near constant partial pressure of oxygen (pO₂) and the mixture is supplied to the diver throughout the depth range of 0-81 msw (0-270 fsw). Previous work indicates that it is feasible to use the current DCIEM HeO₂ mathematical model as a basis for the development of a specific CUMA table.

Defence Relevance

The CUMA cannot be used in its operational role without the tables or procedures for use.

Project Description

The aim of the project is to develop and evaluate decompression tables and procedures for system deployment to support CUMA diving operations safely to a maximum depth of 81 msw (270 fsw). A work program with 4-5 dive series per year is underway. Each series is of three/ four weeks duration and involves approximately 20 divers. This project is essential if the CUMA is to be operated safely to 81 msw. Deployment procedures for the complete system are closely associated with table development and form a vital part of the man/equipment interface. Initial work on this tasking will be devoted to producing a limited set of tables so that the CUMA can be applied immediately for training and operational use.

Associated with this tasking is a joint development project under the ABCA-10 IEP to develop a common probabilistic HeO₂ decompression algorithm. This algorithm would predict safe decompression for any underwater breathing apparatus (UBA) operating at a constant pO₂ and would be applied to CUMA and its operational considerations.

PROGRESS

Testing of in-water oxygen decompression profiles for the CUMA were continued. Series 7, from 1-26 Nov 1993, was conducted with subjects from DCIEM, FDU(A), RAN, RN, USNEDU, and USNMRI. Twenty-nine dives were completed successfully, with 52 wet-dive and 29 standby exposures. Series 8, from 10 Jan - 5 Feb 1994, was conducted with subjects from DCIEM, FDU(A), FDU(P), RAN, RN, USNEDU, and USNMRI. Thirty-one dives were completed successfully with 61 wet-dive and 31 standby exposures. No cases of DCS were observed in either series. The results showed that the in-water oxygen decompression profiles were acceptable although at the longest bottom times studied at the deeper depths, the decompression stress was high. In-water oxygen decompression will not be the primary mode of decompression for the CUMA, especially for these long bottom time dives; however, the study of in-water decompression was needed to validate the decompression algorithm.

Testing of the in-water oxygen decompression profiles is essentially complete. A few more dives will be conducted at shallow depths for moderate exposures. The primary focus for further testing of CUMA tables will be surface decompression with oxygen, building up on the interim tables that have been issued so far. Series 9, scheduled for 7 Mar - 1 Apr, 1994 was cancelled and will be carried out from 9 May - 3 Jun, 1994.

Productivity

Nishi, R.Y. and S.A. McDougall. HeO2 CUMA Decompression Table Dive Trials, Series 5 and 6: In-water Oxygen Decompression Profiles. Technical Memorandum HPSD-94-04, 3752B-T51CD/DMEE 054(HPS), xx Apr 1994.

Nishi, R.Y. and J. Cox. HeO2 CUMA Decompression Table Dive Trials, Series 7 and 8: In-water Oxygen Decompression Profiles. Technical Memorandum HPSD-94-05, 3752B-T51CD/DMEE 054(HPS), xx Apr 1994.

PROJECTIONS

9 May - 3 Jun 1994
12 Sep - 7 Oct 1994
7 Nov - 2 Dec 1994
Jan 1995

Series #9 (CAN/UK/AUS/US)
Series #10 (CAN/UK/AUS/US)
Series #11 (CAN/UK/AUS/US)
Series #12 (CAN/UK/AUS/US)

It is intended to extend this project by 1 year owing to staff reductions.

2. GROUP TASK NO.
DMEE 054

TASK DESCRIPTION SHEET

18. DRE Planning Code
011ZV-11

1. TITLE: CUMA HeO₂ DECOMPRESSION DEVELOPMENT

3. REVISION NO: 1

4. PROJECT SPONSOR: DGMEM/DMEE

5. PROJECT OFFICER: DMEE 4-4, Mr. R. Coren, (613) 997-9288

6. PROJECT DIRECTOR: DRDM 7, LCdr R. Wall, (613) 995-8338

7. REFERENCES: A. 3752B-P51CD (BIO) 27 Apr 90;

B. 14220-81-4 (DMEE 5-4-2) 5 Jun 90

8. DEVELOPMENT PROJECT NO: 011ZV

9. REQUIREMENTS DIRECTORATE: DMEE

10. OTHER INTERESTED DIRECTORATES: DDivS, DNR 7-3, MARCOM

11. BACKGROUND: DCIEM Tech Memo BIO-04 dated 29 Mar 1990 relates that it is practical and feasible to use a mathematical model to control decompression for the new CUMA HeO₂ diving apparatus. This decompression table development is essential if the CUMA apparatus is to be operated safely to 81 msw using both surface and in-water decompression procedures.

12. AIM: To develop and evaluate decompression tables and procedures for system deployment to support CUMA diving operations safely to a maximum depth of 81 msw.

13. SECURITY CLASSIFICATION: UNCLASSIFIED

14. RESOURCES SUPPLIED BY SPONSOR:

15. REQUESTED START DATE: 1 Apr 91

16. COMPLETION ACTION: Final report upon completion in March 1996.

17. SPONSOR'S SIGNATURE:

28. CRAD SIGNATURE:

19. DND RESEARCH ESTABLISHMENT: DCIEM

20. PROJECT SCIENTIST: R. Y. Nishi (416) 635-2140

21. WORK PLAN:

A four year programme with 3-4 dive series per year. Each series will be of three-week duration and involve approximately 20 divers. Initial work will be to produce a Surface Decompression with Oxygen (with In-Water O₂) table. Table will be known as the CUMA HeO₂ Table (SurD O₂) or (In-water O₂) as appropriate.

22. SCHEDULE:
Three to four dive series per year.

23. REPORTING PLANS:

A report will be produced after each Series and a final report on completion.

24. ESTIMATE OF EFFORT AND COSTS:

FISCAL YEAR	93/94	94/95	95/96
PERSON YEARS PROF TECH MIL	0.4 0.8 1.2	0.4 0.8 1.2	0.4 0.8 1.2
GOODS, SERVICES AND EQUIPMENT COSTS			
ESTABLISHMENT COSTS			
DND DEVELOPMENT FUNDS	45K	25K	15K

25. ESTIMATED START DATE: 01 Apr 91

26. ESTIMATED COMPLETION DATE: 31 Mar 96

27. DCIEM SIGNATURE: M. W. Radomski, Chief DATE:

Mine Countermeasures Diving System Development

Project Engineer:	Mr. D.J. Eaton
Project Officer:	Lt. J P Cox (RN)
Start Date:	1 Apr 93
Finish Date:	31 Mar 97
Code:	DPAS 011XN
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

There is little integration of mine-countermeasures (MCM) diving systems. The diving suits are bulky and buoyant making movement through the water difficult and sometimes dangerous. Weight vests for counteracting buoyancy are also bulky and clumsy. Current operating procedures rely heavily on old techniques and doctrines developed using obsolete equipment. The breathing apparatus as presently configured provide little information on the status of life-support system and decompression. Lastly, the supervisor on the surface has no way of helping or controlling the diver.

With the development of the Canadian Underwater Minecountermeasures Apparatus (CUMA) and the Canadian Clearance Diving Apparatus (CCDA) and associated equipment it is apparent that there is a need for review to integrate equipment and techniques available now and under development. The concept of diving to depths of 81 metres in a self-contained breathing apparatus requires review so that new techniques and equipment can be developed to enhance diver monitoring and safety in an MCM environment. To improve the complete MCM system, EDU is investigating a number of these problems. EDU also continues to support the CUMA and CCDA as operational problems arise with the equipment.

Defence Relevance

Mine-countermeasures diving is a dangerous and difficult activity owing to the stress of diving on live explosives and also because of the natural environment. Improving the integration of mine-countermeasures diving systems will help divers perform their work more effectively and safely.

Project Description

The project consists of a number of sub-projects each of which will examine a particular problem area, develop and evaluate alternative solutions and prepare the solution for intro-

duction to the Canadian Forces (CF). Much of this work will be done by EDU; however, some work will be contracted out. In addition, EDU personnel continue to provide In-Service Engineering Assistance (ISEA) for both the CCDA and CUMA.

PROGRESS

1. Weight Vest.

Background. To date the weighting arrangement for the CUMA diver has been inadequate. Soft weight belts have been used along with more conventional weight belts. The problems with the belt arrangements is the concentration of the weight in small areas without adequate support from the harness. The weights tend to hang awkwardly on the diver and move about during the dive. The movement and concentration of weight produces high stresses on divers' backs resulting in frequent complaints of back pain particularly after long swims.

Current Activity. The new design of Weight Vest was produced and evaluated during CUMA training at Fleet Diving Unit Pacific (FDU(P)) in March 94.

Projections. EDU will complete modifications to vests based on field trial findings. Once modifications are validated, EDU will produce a DCIEM report to recommend a final design to the Directorate Maritime and Electrical Engineering (DMEE) by Jun 94.

2. Surface Supplied Gas Panel (SSGP).

Background. During 1991 the US Navy tested a Fullerton, Sherwood Engineering Ltd. (FSEL) CUMA SSGP. The same style of SSGP was purchased by CF along with 2 prototype Surface Supplied CUMA (SS CUMA) from Fullerton Sherwood Engineering Ltd. A SS CUMA would provide longer dive endurance as well as a greater level of safety during training dives.

Current Activity. EDU completed a review of the panel and a preliminary design was produced for a smaller, lighter and more portable panel. Procurement of a panel fitting this new design is in progress.

Projections. Dives will be done by EDU during June 94 in the static tank and the DRF with the new surface supplied CUMA once the sets have been assembled and the changes tested. A report will be produced summarizing the results and recommending further action as required.

3. Face Mask Replacement

Background. The face mask currently in use with CCDA and CUMA, although satisfactory, does have some shortcomings with regard to the ear clearing arrangements. Divers have often complained that when diving CCDA and CUMA there is a lot to do with their hands when descending and forcing the hand on the nose area of the mask sometimes proves difficult to the degree of halting the decent each time they need to clear their ears.

Current Activity. EDU purchased an Admiralty Pattern and an Interspiro full-face mask modified by FSEL to accept the mouthpiece arrangement for CUMA and CCDA and have a nose clearing device built in. EDU has dived a CCDA set with both masks and have found that when clearing the ears the diver can blow through his nose directly onto this device without having to pinch his nose. Should the diver experience "sticky ears" then an additional upward pressure can be applied by pushing the mask upward with either hand to force the nose clearing device closer to the nose, this operation can be carried out while still holding a signal or buddy line.

Projections. EDU will evaluate each facemask during CUMA HeO2 Table Development dive series this year. On completion of In-House evaluations, EDU will conduct a field trial at one of the diving units prior to Mar 95.

4. CUMA Diagnostics Standard Operating Procedure (SOP)

Background. Pre-dive calibration of the CUMA is done using the on-board oxygen diagnostics unit. The procedure requires the diver to open the diagnostic unit to access the electrical connectors. This exposes the diagnostic's electronics to the often damp and wet conditions of a dive site as well as the strain of repetitive connecting and disconnecting. This exposure results in pre-mature failure of the diagnostic's circuitry.

Current Activity. FSEL produced a connection cable that plugs in between the CUMA on-board diagnostic unit and the face mask to carry out Pre-Dive Calibration without opening the diagnostic unit. EDU purchased 6 new connection cables and evaluated them during CUMA training at FDU(P). Results were favourable although there is some concern that the cable causes a power drain on the battery which will require determination of a new specification for minimum battery voltage.

Projections. EDU and FSEL will investigate the cause of the battery power drain, take corrective action and make recommendations via technical memorandum to DMEE for implementation of the new SOP by Jun 94.

5. Through-Water Communications

Background. EDU is looking at methods of communicating with a CUMA/CCDA diver at depth without the need of a hard wire. The obvious solution to the problem is through-water communications. The problem with communications and a CUMA/CCDA diver is the mouthpiece, the diver has difficulty speaking clearly. The problem is further exacerbated due the speech distortion produced by helium.

Current Activity. Funds were not available to evaluate the feasibility of using waterproof transceivers, manufactured by Helle Engineering, for communication via bone conduction. No progress was made since the last review.

Projections. EDU will purchase transceivers from Helle when money is available through this project and evaluate them with the in-service through water communications system as time and resources are made available.

6. Mechanical Winch For Inflatable Diving Boats

Background. A Board of Inquiry Review Panel tasked EDU to find and evaluate a suitable winch to fit to an inflatable boat to assist in recovery of a diver's shot line in CUMA/CCDA MCM operations.

Current Activity. EDU sent MARCOM findings of a market survey and made recommendations regarding further evaluations.

Projections. The evaluation portion of the task will be completed through MARCOM. EDU action is complete.

7. Dry Suit and Dry Suit Underwear

Background. NDHQ recently tendered a new contract for MCM dry suits. Pre-production samples of the suits were sent to EDU by the manufacturer for quality assurance. Additionally, the dry suit underwear manufactured by Pajesga is no longer available. Consequently, the CF is looking for a new supplier of underwear. EDU is taking this opportunity to research materials and combinations of materials that will greatly improve the performance of dry suit underwear. This will include better insulation with less bulk and restriction as well as improved moisture management.

Current Activity. EDU evaluated a second group of samples from the manufacturer (Oceaner). The suits met the contract specification. A report was sent to DMEE recommending the suits for CF use.

M.E.T.A. Research Inc. examined a number of combinations of hydrophylic, hydrophobic and insulative materials settling on two versions. The least compressive version used honeycomb insulation known as Supracor®. The second version used quilted layers of Thinsulate®. Tests with the Supracor® version showed it to be very uncomfortable. The remaining tests will be conducted with the Thinsulate® insulation.

Projections. No further action is required concerning the new dry suits.

M.E.T.A. will continue production and field testing of prototypes. The first prototypes will be available for EDU testing in June 94.

Productivity.

Uglene W. (1994) Incompressible insulation and sweat absorption system for use in diving suits. Phase 1. Contract No. W7711-3-7189/01-XSE, M.E.T.A. Research Inc., Richmond, B.C.

8. CUMA PO2 Diagnostics Assembly

Background. The fault occurred on ascent when the LED failed to turn from green to red at 9 meters when the diver switched to pure O2.

Current Activity. The fault is caused by inadequate temperature compensation of the O₂ sensor output. Modifications, recommended by the manufacturer, to EDU CUMA were completed and evaluated during series 6, 7, and 8 of the CUMA HeO₂ Table Development. Some errors in the diagnostic performance were recorded. These were attributed to inability to adhere to prescribed procedures for preventing large thermal variations.

CUMA at Fleet Diving Unit (Atlantic) (FDU(A)) have not been converted. FDU(A) has carefully followed the procedure to prevent large thermal variations and has not observed the temperature compensation problems.

Diagnostics on training CUMA at Fleet Diving Unit (Pacific) (FDU(P)) were modified and evaluated during OPVAL. The diagnostics worked as expected.

The modification reduces the requirement to strictly adhere to the procedures for prevention of thermal shock; however, the thermal compensation of the oxygen fuel cell is not adequate over the full operating temperature range of CUMA. EDU is examining the possibility of replacing the galvanic fuel cell used for oxygen sensing with fluidic components that will be less sensitive to temperature variation.

A prototype diagnostic system using fluidic elements was fabricated and tested. The results showed that the system was feasible but might be costly because of the high accuracy pressure transducers needed. Optimization of the circuit could reduce the need for high accuracy transducers. The use of fluidic elements would eliminate the need to replace costly galvanic fuel cells; unfortunately, human and monetary resources are not available at this time to continue this research. It is considered more expedient to attempt to correct the temperature compensation of the existing diagnostic.

Productivity.

Reports.

Leask R. (1993) Evaluation of laminar flow elements for the replacement of the CUMA Diagnostics System. DCIEM Co-Op Student Report.

Projections. EDU will continue to monitor the performance of the temperature compensation circuit modifications and report changes in procedure that may be required to deal with the problem to NDHQ. EDU will also examine alternatives for temperature compensation methods.

9. Functional Analysis.

- Reference: A. Minutes of CUMA Progress Meeting dated 17 Feb 92
B. 3752B-P51CD/Task Review (BIO) dated 22 Jan 1992

Background. The merits of functional (or failure mode) analysis were discussed at ref A. The DCIEM (EDU) approach was outlined as follows:

- i. system breakdown into sub-systems and components by reference to CFTO;
- ii. theoretical analysis on part-by-part basis;
- iii. possibility of failure assessment (unlikely, possible etc.);
- iv. effect on diver (minor, dive abort, safety-to-life etc.);
- v. allocation of priority for practical testing (immediate, future, not required).

It was stressed that this work would be conducted on a joint basis with FSEL since some of the work had been completed previously. The objective was to formalise the results and to update SOP's and troubleshooting instructions. A target date of Sep 92 was noted although lack of completion would not jeopardise CUMA diving.

DMEE 4-4 proposed that CUMA functional analysis work be used as the preliminary development of an SOP for the introduction into service of new equipment (ref B.). This was agreed. The final report would be forwarded to DMEE on completion.

Current Activity. EDU functional analysis is 70% complete. No activity since last report. A meeting scheduled for Dec 93 was canceled owing to other commitments.

Projections. EDU will set up a meeting with FSEL for Sep 94.

10. Verdigris build up in Bailout regulators with CCDA and CUMA.

Background. Since the introduction of the Bailout CCDA and CUMA it was noticed that a build up of verdigris was apparent inside the regulator and Low Pressure (LP) delivery hose. The cause of this buildup is uncertain but there are two probable causes, namely water seeping past the "O"-ring seal at the regulator where it fits onto the cylinder and or water (or water vapour) getting into the LP hose via the Counterlung.

Current Activity. EDU continued evaluation of a water trap, developed by the manufacturer, that prevents water getting into the LP hose. EDU converted a CUMA to change the point where the bailout gas enters the system from the counterlung to the scrubber. Evaluations of this proposed solution are being done concurrently with the water trap modification.

Projections. Evaluation of the problem and the proposed solutions will continue. A final recommendation is expected by Nov 94.

11. Bypass UCR.

Reference: A. UCR No. E1450 - 4001

Background. During a CUMA series in December 93 and a Training Dive at FDU (A) a By-Pass Valve failed to fully close after operation. The result of this failure led to an increase in the concentration of oxygen entering the breathing loop. A subsequent UCR was raised, part of which resulted in increasing the periodicity of lubricating the By Pass valve. EDU was tasked to investigate methods of warning the diver that the valve had not fully closed after operation.

Current Activity. To give the diver an indication that the By-Pass valve has fully closed after operation, preparations have been made to evaluate re-routing the by-pass gas through the diagnostic unit during CUMA series 9 commencing 9 May 94 and will continue through CUMA series 10 in September 94 and if necessary series 11 (not yet scheduled).

The evaluation will record differences in oxygen partial pressure recorded using the SERVOMEX paramagnetic oxygen analyzer and the diagnostics oxygen fuel cell between 2 CUMA that route the by-pass gas normally and 1 CUMA that has the gas routed through the diagnostic unit.

The results of the evaluation should enable EDU staff to determine if, by rerouting the gas through the diagnostic unit, any detrimental effect is experienced by the fuel cell or any other component of the diagnostic unit.

Projections. The results will be sent to DMEE along with any recommendations by Jan 1995.

2. GROUP TASK NO.
DMEE

TASK DESCRIPTION SHEET

18. DRE Planning Cou.
011XN-

1. TITLE: MINECOUNTERMEASURES DIVING SYSTEM DEVELOPMENT

3. REVISION NO:

4. PROJECT SPONSOR: DMEE 4

5. PROJECT OFFICER: DMEE 4-4, Mr. R. Coren, (819) 997-9288

6. PROJECT DIRECTOR: DRDM 7

7. REFERENCES: A. Minutes Maritime Command Diving Working Group, May 92
B. Minutes Diving Task Review Meeting, 5 Nov 92

8. DEVELOPMENT PROJECT NO: 011XN

9. REQUIREMENTS DIRECTORATE: DNR 7

10. OTHER INTERESTED DIRECTORATES: D Div S

11. BACKGROUND: DCIEM completed development of a diving set which will allow self-contained MCM diving to 81 metres. There is little thermal protection for the diver and the set as presently configured provide little information on the status of the life-support system and decompression. Lastly, the supervisor on the surface has no way of helping or controlling the diver.

12. AIM/To develop systems which will provide thermal protection for the diver, information on the status of the life-support system and decompression and which will allow the dive supervisor to precisely monitor and control the diver in an MCM/EOD environment.

13. SECURITY CLASSIFICATION: UNCLASSIFIED

14. RESOURCES SUPPLIED BY SPONSOR: Development funds identified within CRAD DPAS 011XN for FY94/95 through FY96/97.

15. REQUESTED START DATE: 1 Apr 94

16. COMPLETION ACTION: A. Successful field trials of equipment and procedures developed; and B. DCIEM Report.

17. SPONSOR'S SIGNATURE:

28. CRAD SIGNATURE:

19. DND RESEARCH ESTABLISHMENT: DCIEM

20. PROJECT SCIENTIST: Mr. David Eaton, (416) 635-2086

21. WORK PLAN: A. MCM dry suit testing (Nov 93-Jul 94); B. Replacement CUMA facemask and weight vest development (Nov 93 - Jul 95); C. Validation of operating procedures for CUMA in MCM scenario (Apr 94 - Mar 96); D. Testing and evaluation of PSEL CUMA PO2 sensors (Apr 95 - Mar 96); E. Development and testing of pressure transducers for bottles/depth (Apr 95 - Mar 96); F. Development and testing of underwater decompression computer (Jan 95 - Dec 96); G. Development and testing of CUMA Surface Supplied System (95/96); H. Testing and evaluation of diver locating system (GPS/USN diver mounted short-base line system) on diver's and ROV's (1996); I. Evaluation of underwater communications systems for use in MCM environments (Apr 94 - Dec 94); and J. Development of integrated MCM diver-mounted computer with HUD (Apr 96 - Mar 97)

22. SCHEDULE: As in para 21.

23. REPORTING PLANS: On completion of each milestone.

24. ESTIMATE OF EFFORT AND COSTS:

FISCAL YEAR	94/95	95/96	96/97
PERSON YEARS	0.5	0.5	0.5
PROF TECH	0.3	0.3	0.3
MIL	0.5	0.5	0.5
GOODS, SERVICES AND EQUIPMENT COSTS			
ESTABLISHMENT COSTS			
DND DEVELOPMENT FUNDS	40K	60K	40K

25. ESTIMATED START DATE: 01 Nov 93

26. ESTIMATED COMPLETION DATE: 31 Mar 97

27. DCIEM SIGNATURE: M. W. Radomski, Chief DATE:

Clearance Divers' Supplementary Heater

Project Scientist:	D. Eaton
Project Officer:	Lt (RN) J. Cox
Start Date:	11 May 89
Finish Date:	31 Mar 96
Code:	DMEE 051, DPAS 0516Y-11
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

The major limiting factor to work and prolonged excursion in cold water is excessive cooling and discomfort of the extremities. This fact was reinforced during the Diver Thermal Protection Workshop held at DCIEM in Feb 1989 and at the Information Exchange Program (IEP) ABCA-10 meeting in Jun 1991. The Canadian Forces (CF), United States Navy and Royal Navy have all recognized the problem and are developing solutions. The Canadian approach initially investigated the feasibility of a technique for catalytic combustion of alcohol developed by Atomic Energy of Canada Ltd. (AECL) as a heat source. However, information presented at the June 1991 ABCA-10 meeting prompted the start of an investigation of the use of heating the hands and feet with an electrical energy source. Further investigation of catalytic heating revealed a longer development period than expected; consequently, the project has concentrated on electric heating for the hands and feet as well as expanding to considering whole body electric heating. The catalytic heating system will reported under a separate project.

Defence Relevance

The heating system forms an integral part of the Canadian Underwater Minecountermeasures Apparatus (CUMA) development programme. Without hand heating, clearance divers will not be able to safely complete the longer and deeper dive profiles capable with CUMA. If whole body heating with electricity is successful, the technique will make surface supplied diving with CUMA more feasible as heating will be required for the longer durations capable. Whole body electrical heating will also improve other light weight surface supplied diving by providing a heat source where no other was available. Standard surface supplied diving will also benefit as electrical energy sources would replace the potentially hazardous and inefficient diesel fired heaters as well as the bulky hot water diving suits with a more reliable energy supply and dry diving suits.

Project Description

The initial aim was to combine AECL's catalytic combustion system with heat transfer garments into a field portable unit that could be evaluated in open water.

However, after AECL successfully produced laboratory models of heaters and tubing gloves, information regarding electrical power supplies showed that, given the present state of catalytic technology, an electrical energy source would be much easier and less costly to develop, purchase and maintain than the catalytic based heater. Consequently, a second contract to Exotemp, a spin-off company of AECL, was let to produce heating gloves powered from a battery supply. Evaluation of the gloves is the responsibility of the Experimental Diving Unit (EDU).

Whole-body electrical heating systems will be purchased from Exotemp Systems and evaluated by EDU.

PROGRESS

Exotemp Systems produced a new battery design to eliminate a number of problems. The new design is modular so that individual NiCad cells can be replaced if they fail or the connector can be replaced. The new design also incorporates a recessed connector to decrease the likelihood of connector fracture and large, soft rubber bump guards to protect the battery from vibration and impact. The new carrying handle also serves as a stop to keep the battery from rolling. EDU tested the new batteries during CUMA Decompression Series 7 and 8 and found them to work satisfactorily.

The two new versions of the gloves were also tested. One version used a short whip extending from the back of the glove to locate the electrical connector while in the other version the connector was attached directly to the back of the glove. Divers preferred and wear and tear on the gloves showed that the configuration with the connector attached directly to the back of the glove was the most favourable. However, glove durability is still a question of concern.

New gloves were purchased with the connector attached to the back of the glove. These gloves were used during TECHVAL S869 at FDU(P). The trial was cut short as one of the connectors between the wiring harness and the battery broke and, owing to equipment shortages, it was considered prudent to postpone the evaluation. The failure occurred as a result of slippage of the connector protector down the wiring harness. This exposed the connector which made it susceptible to breakage.

This connector has been a constant problem in the project. A new configuration that eliminates the connector is being developed. This will require the divers to connect each glove individually.

Two whole-body heating systems were purchased from Exotemp Systems.

Productivity:

Nil reports.

PROJECTIONS

The gloves and battery evaluation will continue during CUMA decompression table development dives. The feasibility of having the diver connect to each individual glove will be examined during Series 9 in May 1994. If successful, a modification to the system will be designed, procured and tested. An interim report on the performance of the system with the diver connecting at the gloves will be produced by Sep 1994.

Comparison of whole-body electrical heating systems to hot water systems will take place during a series of dives scheduled for June 1994.

This project has been extended one year to Mar 1996 owing to staff reductions and inclusion of whole body heating.

2. GROUP TASK NO.
DMEE 051

TASK DESCRIPTION SHEET

18. DRE Planning Code
0516Y-11

1. TITLE: CLEARANCE DIVERS' SUPPLEMENTARY HEATER

3. REVISION NO: 4

4. PROJECT SPONSOR: DGMEM/DMEE

5. PROJECT OFFICER: DMEE 4-4, Mr. R. Cören, (819) 997-9288

6. PROJECT DIRECTOR: DRDHP 7, Maj A. St. Onge (613) 995-4795

7. REFERENCES:

8. DEVELOPMENT PROJECT NO: 0516Y

9. REQUIREMENTS DIRECTORATE: DMEE

10. OTHER INTERESTED DIRECTORATES: DDivS, DNR 7-3, MARCOM

19. DND RESEARCH ESTABLISHMENT: DCIEM

20. PROJECT SCIENTIST: Mr. D. Eaton (416) 635-2086

21. WORK PLAN: 1. Test, modify and re-test electric hand heating system as required.
2. OPVAL of hand heating system.

3. Post OPVAL modifications and testing.

4. Design freeze of hand heating system.

5. Whole body heating safety analysis.

6. Purchase and evaluation of existing whole body heating system.

7. Whole body heating system design modifications, testing, modification and re-test as required.

8. Whole body heating system TECHVAL, analysis, modification and re-test.

9. Whole body heating system OPVAL, analysis, modification and re-test.

10. Design freeze of whole body heating system.

22. SCHEDULE: 1. Jan 1994, 2. Apr 1994, 3. Aug 1994, 4. Sep 1994, 5. Jan 1994, 6. Jul 1994, 7. Dec 1994, 8. Jul 1995, 9. Jan 1996, 10. Mar 1996

23. REPORTING PLANS: Reports upon completion of 4. and 10., which will include manuals.

24. ESTIMATE OF EFFORT AND COSTS:

FISCAL YEAR	93/94	94/95	95/96
PERSON YEARS	0.1	0.1	0.1
PROF	0.1	0.1	0.1
TECH	0.5	0.5	0.5
MIL			
GOODS, SERVICES AND EQUIPMENT COSTS			
ESTABLISHMENT COSTS			
DND DEVELOPMENT FUNDS	60K	30K	30K

25. ESTIMATED START DATE: 1 Jul 1989

26. ESTIMATED COMPLETION DATE: Mar 1996

11. BACKGROUND: Clearance divers require an active heating system to prevent hypothermia in cold water operations. Passive thermal protection is insufficient because the diver invariably loses hand dexterity within an hour. In-service hot-water-heating is unreliable and inefficient as well as unsuitable for self-contained and light weight surface supplied operations. Therefore, heating systems are needed for self-contained and surface supplied divers.

12. AIM: To provide an active heating systems for clearance divers during prolonged self-contained diving operations to 81msw that will prevent discomfort and dexterity loss in divers hands and another heating system to replace existing whole body hot water heating systems.

13. SECURITY CLASSIFICATION: UNCLASSIFIED

14. RESOURCES SUPPLIED BY SPONSOR: Development funds as required.

15. REQUESTED START DATE: 1 July 1989

16. COMPLETION ACTION:

17. SPONSOR'S SIGNATURE:

28. CRAD SIGNATURE:

27. DCIEM SIGNATURE: M. W. Radomski, Chief DATE:

SDL Emergency Life Support CO2 Scrubber/Absorbent

Project Scientist:	Mr. D. Eaton
Project Officer:	Lt.(N) J.A. Frew
Start Date:	1 September 1992
Finish Date:	31 May 1994
Code:	DMEE 59, DPAS 0518S
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

OPVAL S758 confirmed SDL-1's (Submersible Diver Lockout 1, an atmospheric diving vessel with the capability to transport ambient pressure divers to and from a dive site) capability to provide up to 5 occupants with 7 days of emergency life support. EDU also recommended further investigation into lung-powered scrubbers for use in a lost power scenario.

EDU subsequently conducted a comparison trial of available CO₂ scrubber systems. In a Technical Memorandum dated 15 May 1991, EDU recommended the Kinergetics AquaBreeze II scrubber system for use in SDL-1. During the same time period EDU developed a hand-crank mechanism designed to operate the AquaBreeze II scrubber in a lost power scenario. EDU Technical Memorandum dated 31 May 1991 recommended the use of the hand-crank assembly with the AquaBreeze II scrubber in SDL-1.

During the SDL-1 refit in the spring of 1992, International Submarine Engineering fitted an AquaBreeze II CO₂ scrubber in SDL-1.

EDU sent the hand-crank mechanism to HMCS CORMORANT in May 1992 for an *in situ* trial (to be conducted upon completion of SDL-1 and HMCS CORMORANT refits).

In March of 1992, HMCS CORMORANT requested that DMEE extend the SDL-1 Emergency Life Support tasking (DMEE 044) to investigate the use of lithium hydroxide (LiOH) with the AquaBreeze II scrubber (in lieu of soda lime). Instead, DMEE initiated a new tasking (DMEE 059) aimed at determining the benefits and assessing the hazards of using LiOH in the CF submersible CO₂ scrubber systems. NDHQ officially closed DMEE 044 in the fall of 1992.

Defence Relevance

The SDL-1 uses LiOH (Poly Research Corp) as the emergency scrubber material in the

SDL-1 while Pisces IV uses LiOH as its primary scrubber material. However, the storage requirements for spare LiOH and the compatibility with the new AquaBreeze scrubber canisters have never been verified. Trials conducted during the project will also determine whether LiOH is suited for use in CF hyperbaric chambers.

Project Description

This project has 5 main objectives:

- a. compare the efficiency of LiOH and soda lime scrubbing materials (using both the radial flow AquaBreeze scrubber basket and the LiOH axial flow canister);
- b. determine effects on efficiency of the AquaBreeze II system when fitted with a prototype external filter (designed to capture all LiOH dust which might be blown through the canister);
- c. determine the shelf life of the LiOH material;
- d. assess the compatibility of LiOH and the materials which make-up AquaBreeze II scrubber basket; and
- e. formulate standard operating procedures (SOP's) necessary for the safe handling of LiOH.

PROGRESS

Comparison of endurance using LiOH in the axial flow Poly Research Corp. canister versus soda lime in the radial flow Aquabreeze II canister were completed in December 1993. The results showed that the latter configuration provided longer endurance. Based on the results, EDU recommended (by message to D.T.G.) that the use of LiOH in the Poly Research canister in the SDL -1 be discontinued and that mission requirements be met with soda lime in Aquabreeze II canisters.

Shelf life, compatibility trials and the determination of endurance when using LiOH in the Aquabreeze II canister were completed in Mar 94. The data has been analyzed and a report is being prepared. In summary, LiOH retained its CO₂ absorption capacity over the two years of the test; LiOH was compatible with the Aquabreeze II scrubber, and scrubber endurance with LiOH in the Aquabreeze II was significantly better than soda lime; however, the SOP's needed for safe handling of LiOH precludes using it without a pre-packaged, filtered scrubber canister.

Productivity

Nil Reports.

PROJECTIONS

EDU will complete a DCIEM report describing the evaluations by 31 May 94.

1. TITLE: SDL-1 EMERGENCY LIFE SUPPORT CO2 SCRUBBER/ABSORBENT

3. REVISION NO:

4. PROJECT SPONSOR: DGMEM/DMEE

5. PROJECT OFFICER: DMEE 4-4, Mr. R. Coren (819) 997-9288

6. PROJECT DIRECTOR: DRDHP 7, Maj A. St. Onge (613) 995-4795

7. REFERENCES: A. BIO TM 91-08, 8 May 9; B. 271500Z Mar 92 DMEE 5605
C. 301933Z Apr 92 BIO 192

8. DEVELOPMENT PROJECT NO: 0518S

9. REQUIREMENTS DIRECTORATE: DNR 7

10. OTHER INTERESTED DIRECTORATES: DDivS, HMCS Cormorant

11. BACKGROUND: Originally aimed at identifying a lung powered CO₂ scrubber that was compatible with the SDL-1. Lung powered scrubbers were found unsuitable and a hand crank mechanism was developed. An investigation was conducted into the use of LiOH in CF submersibles. LiOH CO₂ scrubber material has been used in both SDL-1 (as emergency scrubber material supply) and Pisces IV (as primary scrubber material); however, there was no data on the efficiency or compatibility of this material with the new AquaBreeze II CO₂ scrubbers recently installed in the SDL-1.

12. AIM: To determine the benefits and assess the hazards of using LiOH (lithium hydroxide) in CF submersible CO₂ scrubber systems and to evaluate the efficiency of LiOH.

13. SECURITY CLASSIFICATION: UNCLASSIFIED

14. RESOURCES SUPPLIED BY SPONSOR: Development funds available within CRAD account 011WF.

15. REQUESTED START DATE: 1 July 1992

16. COMPLETION ACTION: Tech memos on completion of all phases.

17. SPONSOR'S SIGNATURE:

28. CRAD SIGNATURE:

19. DND RESEARCH ESTABLISHMENT: DCIEM

20. PROJECT SCIENTIST: David Eaton (416) 635-2086

21. WORK PLAN: A. Conduct a comparison trial using the AquaBreeze II CO₂ Scrubber motor to determine the efficiency of LiOH material (as compared to soda lime) using the AquaBreeze II scrubber basket and the LiOH canister (one month); B. conduct a compatibility trial to determine effects of long term storage of LiOH material in an AquaBreeze II scrubber basket (24 months); C. conduct trial with a prototype external AquaBreeze II scrubber basket filter to determine the effects on flow rates (one week); D. determine the effects of long-term storage on LiOH performance (12 months); and E. formulate SOP's for safe handling of LiOH material (24 months).

22. SCHEDULE: Trials will commence upon receipt of LiOH material. The timeframe for each phase (A-E) is noted in Work Plan (para 21.)

23. REPORTING PLANS: Evaluation reports at the end of 5., 6., 10., 11., 13., 14. Final report at end of 15.

24. ESTIMATE OF EFFORT AND COSTS:

FISCAL YEAR	92/93	93/94	94/95
PERSON YEARS	0.2	0.2	0.1
TECH	0.3	0.3	0.1
MIL	0.3	0.3	0.1
GOODS, SERVICES AND EQUIPMENT COSTS			
ESTABLISHMENT COSTS			
DND DEVELOPMENT FUNDS	10K	10K	

25. ESTIMATED START DATE: 01 Jul 92

26. ESTIMATED COMPLETION DATE: 31 Sep 94

27. DCIEM SIGNATURE: M. W. Radomski, Chief DATE:

Diving in Contaminated/Polluted Water

Project Scientist:	D. Eaton
Project Officer:	Lt.(N) J.A. Frew
Start Date:	27 Aug 92
Finish Date:	31 Aug 94
Code:	DMEE 057, DPAS 0518V
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

There is a perceived threat to Canadian Forces (CF) divers from the contaminants/pollutants in our National waterways. The CF can provide divers a modicum of protection with equipment available commercially or in existing inventory. The materials making up this equipment need to be tested and evaluated to determine exposure limits and contaminated water diving ensembles must be identified. Prior to designing adequate protective measures the CF must identify the threat to the diver.

Every level of government in Canada conducts some form of environmental assessment work. Data required to determine contaminant levels in national waterways may exist but it must be extracted from the various federal, regional, provincial and municipal agencies responsible for the environment.

Defence Relevance

ABCA-10 members agreed to develop a programme addressing the contaminated water diving issue. NATO is also investigating this problem and formed STANAG 1408 UD working party to address these concerns.

The recovery of a downed Snow Bird jet aircraft (August 1989, Lake Ontario) and diving operations during the Gulf Conflict emphasized deficiencies in current CF diving equipment when used in polluted water.

Project Description

The three main objectives of this project are:

- a. determine the capability of current service diving equipment to safeguard personnel from known common contaminants;

- b. develop a self contained CABA system from commercially available or in-service equipment for use in polluted national waters; and
- c. develop guidelines for diving safely in contaminated waters.

PROGRESS

A field trial (OPVAL S870—Contaminated Water Diving Ensemble) was conducted in Fleet Diving Unit (Pacific) in Mar 94. A team from EDU attended. The OPVAL evaluated the dry suit features and assessed the integration of the diving ensemble including full facemask, dry suit, life vest, weight belt and swim fins.

Acres International completed the first three phases of a contract to determine the specific threat to CF divers in our national waterways. A draft report has been produced that identifies and classifies water pollutants in CF diving sites across Canada. The report also attempts to quantify the risk to the diver from the pollutants.

EDU personnel met with Environmental Sciences Group in Royal Roads Military College and obtained the Phase 1 report they produced on the "Historical Inputs, Marine Sediment Contamination and Biological Uptake" in Esquimalt Harbour.

Productivity

Diver Health Risk Assessment (Draft Report of Phases I-III), Acres International Environmental and Waste Management Services, 5 Apr 94.

PROJECTIONS

An ongoing "market watch" will be continued in search of new diving equipment which would be suitable for this application.

Based on the findings of the Acres study, destructive testing of diving ensemble materials will not be conducted. It was decided that Phase IV of the Acres study would be unnecessary.

A report on OPVAL S870 will be completed by 6 May 94. EDU will use the results of OPVAL S870 and Saturation Dive 1/93 to make adjustments to the microbial dry suit ensemble and operating procedures to produce recommendations for a CF Contaminated Water Ensemble for Compressed Air Breathing Apparatus diving. The final report will be submitted by 31 Aug 94 to complete this tasking.

2. GROUP TASK NO.
DMEE 057

TASK DESCRIPTION SHEET

18. DRE Planning Code
0518V-11

1. TITLE: DIVING IN CONTAMINATED/POLLUTED WATER

3. REVISION NO:

4. PROJECT SPONSOR: DGMEM/DMEE

5. PROJECT OFFICER: DMEE 4-4, Mr. R. Coren (819) 997-9288

6. PROJECT DIRECTOR:

7. REFERENCES: A. 3150-1 (DNR) 23 Jul 91;

B. 14220-81-3 (DMEE 5-5-5) 5 Mar 92

8. DEVELOPMENT PROJECT NO: 0518V

9. REQUIREMENTS DIRECTORATE: DNR

10. OTHER INTERESTED DIRECTORATES: D Div S

11. BACKGROUND: CF divers may be required to conduct diving operations in contaminated/polluted waters that pose a health risk to humans. To safeguard divers from harmful contaminants/pollutants, there is an urgent need to develop equipment and procedures which will protect divers and surface support personnel from these hazards.

12. AIM: To develop equipment and operating procedures to conduct diving operations safely in polluted/contaminated waters.

13. SECURITY CLASSIFICATION: UNCLASSIFIED

14. RESOURCES SUPPLIED BY SPONSOR: Development funds identified within CRAD account 011XN for FY 92/93. Additional funds allocated from 0518V.

15. REQUESTED START DATE: 1 Apr 1992

16. COMPLETION ACTION: a. Determine capability of current service diving equipment to safeguard personnel from known contaminants/pollutants; b. develop self-contained CABA system from commercially available or in-service equipment for use in polluted national waters; and c. develop guidelines for diving safely in contaminated waters.

17. SPONSOR'S SIGNATURE:

28. CRAD SIGNATURE:

19. DND RESEARCH ESTABLISHMENT: DCIEM

20. PROJECT SCIENTIST: Mr. David Eaton (416) 635-2086

21. WORK PLAN: A. Determine capability of current service diving equipment to safeguard personnel from known common contaminants/pollutants: (i) inventory existing equipment (Jul 92); (ii) adopt method for classifying hazardous materials (Aug 92); compile data on effects of various contaminants on equipment inventory (Aug 93); (iv) match protective levels of dive equipment to classes of hazardous materials (Mar 94). B. Develop self-contained CABA system from commercially available or in-service equipment for use in polluted national waters: (i) conduct market survey (Mar 93); (ii) assemble & test selected equipment (Mar 94). C. Develop guidelines for diving in contaminated waters: (i) establish method of assessing hazards in national waterways (Aug 93); (ii) identify & define operational modes (May 94); formulate SOP in event hazard level exceeds capability of equipment (May 94); identify training requirements (Aug 94); develop SOP's for diving and topside personnel (Aug 94).

22. SCHEDULE: See para 21 above.

23. REPORTING PLANS: At annual task review meeting with final report.

24. ESTIMATE OF EFFORT AND COSTS:

FISCAL YEAR	92/93	93/94	94/95
PERSON YEARS PROF TECH MIL	0.2 0.4	0.3 0.1 1.6	0.1 0.9
GOODS, SERVICES AND EQUIPMENT COSTS			
ESTABLISHMENT COSTS			
DND DEVELOPMENT FUNDS	20K	40K	40K

25. ESTIMATED START DATE: 01 Apr 92

26. ESTIMATED COMPLETION DATE: 31 Aug 94

27. DCIEM SIGNATURE: M. W. Radomski, Chief DATE:

Deep Diving Training and Acclimatization

Project Scientist:	Mr. W. Fraser
Start Date:	1 October 1993
Finish Date:	1 October 1996
Code:	DPAS 0519G
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

Years of deep diving experience in NATO countries has shown that divers who carry out deep or long dives after a long layoff of no diving are exceptionally prone to Decompression Sickness (DCS). Traditionally, operational units have done "Work-up" dives of varying depths and durations to ameliorate this effect, with varying degrees of success. Other Navies, such as the RN, have formal policies laid down in their Diving Manuals, but without any scientific basis for their design. No formal training or work-up procedures exist in the CF. There is a need to discover the physiological mechanisms which cause this problem and develop procedures which can be operationally applied to reduce the hazard.

There is strong evidence from preliminary studies that bubble-activation of blood complement, a sub-system of the human immune system, is a significant causative factor in DCS.

Defence Relevance

It is often the case that an operational diving unit or team will be tasked to carry out a deep diving job at short notice. The operational Commander should have confidence the operational units are worked-up by means of a scientifically valid schedule, or should at least know that a certain lead-time is required for the units to mount a deep diving job.

Project Description

The Project has commenced with a Literature Review. A Longitudinal Study of individual divers blood complement levels is about to start now that funding has been approved by DRDHP. In the medium term, testing of subjects during CUMA decompression table trials will take place (May 94 - Apr 96). Several Dive Series dedicated to validate or modify the hypothesis will take place in 1996, followed by development of operational procedures for use in deeper diving and diver MCM operations.

PROGRESS

Literature review in progress.

Deep Diving Training and Acclimatization

Project Scientist:	Mr. W. Fraser
Start Date:	1 October 1993
Finish Date:	1 October 1996
Code:	DPAS 0519G
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

Years of deep diving experience in NATO countries has shown that divers who carry out deep or long dives after a long layoff of no diving are exceptionally prone to Decompression Sickness (DCS). Traditionally, operational units have done "Work-up" dives of varying depths and durations to ameliorate this effect, with varying degrees of success. Other Navies, such as the RN, have formal policies laid down in their Diving Manuals, but without any scientific basis for their design. No formal training or work-up procedures exist in the CF. There is a need to discover the physiological mechanisms which cause this problem and develop procedures which can be operationally applied to reduce the hazard.

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Defence Relevance

It is often the case that an operational diving unit or team will be tasked to carry out a deep diving job at short notice. The operational Commander should have confidence the operational units are worked-up by means of a scientifically valid schedule, or should at least know that a certain lead-time is required for the units to mount a deep diving job.

Project Description

The Project has commenced with a Literature Review. A Longitudinal Study of individual divers blood complement levels is about to start now that funding has been approved by DRDHP. In the medium term, testing of subjects during CUMA decompression table trials will take place (May 94 - Apr 96). Several Dive Series dedicated to validate or modify the hypothesis will take place in 1996, followed by development of operational procedures for use in deeper diving and diver MCM operations.

PROGRESS

Literature review in progress.

2. GROUP TASK NO.

DMEC 060

TASK DESCRIPTION SHEET

18. DRE Planning Code

0519G-11

1. TITLE:

DEEP DIVING TRAINING/ACCLIMATIZATION

3. REVISION NO:

4. PROJECT SPONSOR: DGMEM/DMEC

5. PROJECT OFFICER: DMEC 4-4, Mr. R. Coren, (819) 997-9288

6. PROJECT DIRECTOR: DNR 7-3, LCDR D. Kirby, (819) 994-8799

7. REFERENCES: A. Minutes Maritime Command Diving Working Group, May 92

8. DEVELOPMENT PROJECT NO: 0519G

9. REQUIREMENTS DIRECTORATE: DNR 7

10. OTHER INTERESTED DIRECTORATES: D Div S

19. DND RESEARCH ESTABLISHMENT: DCIEM

20. PROJECT SCIENTIST: Mr. W.D. Fraser (416) 635-2064

21. WORK PLAN: A. Literature Review (Aug 94); B. Longitudinal Study of individual subjects' blood complement levels (May 94 - Jun 95); C. Testing of subjects during Cdn Underwater MCM Apparatus decompression table trials (May 94 - Apr 96); D. Develop Work-up schedule hypothesis (Apr - Jun 96); E. Dedicated Dive Series to validate/modify hypothesis (Jun 96 - Mar 97); and F. Develop operational procedures for use in deeper diving and diver MCM operations (Feb - Mar 97).

22. SCHEDULE: As in para 21.

23. REPORTING PLANS: On completion of each milestone.

11. BACKGROUND: There is strong evidence to suggest that divers who carry out deep or long dives after a long layoff of no diving are exceptionally prone to Decompression Sickness. There is a need to discover the physiological mechanisms which cause this problem and develop procedures which can be operationally applied to reduce the hazard.

12. AIM: To discover the cause of increased Decompression Sickness among non-worked up divers and reduce or eliminate its effects.

13. SECURITY CLASSIFICATION: UNCLASSIFIED

14. RESOURCES SUPPLIED BY SPONSOR: Development funds identified within CRAD DPAS at para 8 for FY94/95 through FY96/97.

15. REQUESTED START DATE: 1 Apr 93

16. COMPLETION ACTION: A. Publish papers describing the cause of increased Decompression Sickness risk. B. Recommend procedures to reduce or eliminate this problem.

17. SPONSOR'S SIGNATURE:

28. CRAD SIGNATURE:

24. ESTIMATE OF EFFORT AND COSTS:

FISCAL YEAR	94/95	95/96	96/97
PERSON YEARS	0.5	0.5	0.5
PROF TECH	0.3	0.3	0.3
MIL	0.5	0.5	0.5
GOODS, SERVICES AND EQUIPMENT COSTS			
ESTABLISHMENT COSTS			
DND DEVELOPMENT FUNDS	30K	40K	40K

25. ESTIMATED START DATE: 01 Apr 93

26. ESTIMATED COMPLETION DATE: 31 Mar 97

27. DCIEM SIGNATURE: M. W. Radomski, Chief DATE:

Development of a Common HeO2 Probabilistic Model of Decompression

Project Scientists:	R. Y. Nishi, P. Tikuisis
Start Date:	September 1991
Finish Date	October 1995
Authorization:	Joint Development Project under ABCA-10 IEP
Related Project Code:	DMEE 54, DPAS 011ZV
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

Probabilistic models of decompression are based on the statistical analyses of real dive data using the principle of maximum likelihood. The analyses require an accurate representation of the time-depth-gas profile for the entire dive and the DCS outcome. These models were first investigated by P.K. Weathersby of the US Navy and the initial development by the US Navy relied heavily on dive data from DCIEM. A close collaborative effort has existed between DCIEM and the US Navy, resulting in a number of co-authored reports and publications in the open literature. DCIEM has been exploring different aspects of the models separate from the directions being taken by the US Navy, in particular, the application of the model to helium-oxygen diving.

Both the CF and USN currently have diving equipment requiring a constant PO₂ decompression table and had independently embarked on a development program for HeO₂ decompression tables - DCIEM for CUMA, and the USN for the Mark 16/19 underwater breathing apparatus. At the ABCA-10 IEP meeting in Jun 1991, it was proposed by the US Navy that DCIEM and the USN join together to develop a common HeO₂ decompression probabilistic algorithm to predict safe decompression for any underwater breathing apparatus (UBA) operating at a constant PO₂ or constant fraction of O₂. The application of the model would differ and be tailored to fit the individual UBA's and related operational considerations.

Defence Relevance

Underwater breathing apparatus such as the CUMA cannot be used without a complete set of decompression tables. Conventional methods of developing decompression tables are limited and would require considerable resources in terms of time and man-power to achieve the complete set of tables necessary to expand the operational role of the CUMA. This work will form the basis of a common algorithm for HeO₂ diving to be developed

jointly by the US Navy and DCIEM to extend the operational capability to deeper and longer dives on HeO₂ and to allow either constant mixture or constant PO₂ dives.

Project Description

To develop a common HeO₂ decompression algorithm based on probabilistic methods which can be used to develop decompression profiles for any HeO₂ mixture (constant PO₂ or constant fraction O₂) to meet the operational needs of the participating organizations.

Data used for generating the parameters of the risk models have been obtained primarily from the CANDID diving data base. Some air and helium dive data have been received from the US Navy. A preliminary HeO₂ model has been derived and used to investigate different decompression procedures and to estimate the risk of DCS in the new DCIEM/CF HeO₂ surface-supplied decompression tables.

The joint development project has been established under the auspices of the ABCA-10 IEP. The development would be carried out by a Working Committee consisting of personnel from DCIEM, NMRI and NSMRL, and would be overseen by a Steering Committee composed of the ABCA-10 national leaders and an Operations Committee composed of representatives from NAVSEA 00C, USNEDU, NAVEODTECHCEN, NMRI, NSMRL, DCIEM (EDU), RN Supt of Diving, RN Inst. Naval Med., and the Royal Australian Navy. The terms of reference for this joint project were coordinated by DCIEM (EDU).

The Working Committee members consist of Chairman, R.Y. Nishi (DCIEM), Vice-Chairman, Dr. L.D. Homer (NMRI), Capt. E. Thalmann (NMRI), Dr. P. Tikuisis (DCIEM), and Capt. P.K. Weathersby (NSMRL). Other personnel from NMRI, DCIEM, DRA Alverstone, NSMRL and NEDU have been added as working participants, not formal members of the committee, to help in the effort and attend Working Committee meetings for scientific input.

PROGRESS

The seventh meeting of the Working Committee was held on Dec. 1-2, 1993 in Bethesda, MD. Discussions concerned the assembling of the HeO₂ data set. Data from DCIEM dives, USNEDU, and DRA (Alverstone) were being reviewed and prepared in the right format for the master dataset. The benchmark for the assembly of the primary helium diving database was pushed back from Nov 1993 to February 1994. Any additional data will be extra to the master dataset. A number of issues related to modelling multiple gases and bubble models were discussed. Work required to meet the June 1994 deadline for establishment of the final candidate model was discussed. Although the USN and DCIEM effort were taking different approaches for modelling, it was becoming clear that the two approaches were starting to converge, making possible one final model in the end. One issue that arose from the sixth meeting of the Working Committee was the problem of intellectual property rights arising from this multi-national effort. The next meeting will be held in June 1994 at the Undersea and Hyperbaric Medical Society Annual Scientific

Meeting in Denver, CO.

Part of the DCIEM 84/16 helium data has now been incorporated in the master helium dataset. The rest of that data and the CUMA data are being reviewed and formatted. The modelling effort is continuing with refinement of the bubble model and the oxygen effect on decompression using the same helium dataset being used by the USN.

Productivity

Reports

Tikuisis, P. and R.Y. Nishi. Role of oxygen in a bubble model for predicting decompression illness. DCIEM No. 94-04, January 1994.

PROJECTIONS

The status of all milestones will be reviewed at each meeting.

- | | |
|-------------|---|
| 1. Jun 1994 | Establishment of final candidate models.(Possible models to be tried with N2 data set.) |
| 2. Nov 1994 | First laboratory dives - DCIEM |
| 3. Oct 1995 | Final validation dives - NEDU |

Role of Exercise During Decompression

Project Scientists:	L.W. Jankowski (Visiting Scientist), R.Y. Nishi
Project Engineer:	D.J. Eaton
Start Date:	November 1993
Finish Date:	December 1994
Code:	DCIEM 51CD
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

During hyperbaric exposures, exertion and elevated body temperature increase perfusion of the exercising limb tissues and apparently accelerate inert gas absorption. Inert gas transport is generally facilitated by heating and reduced by cooling. The risk of decompression sickness after working dives may be exacerbated if warming exertion is followed by cooling during periods of extended decompression at rest. Since physical exercise during diving increases the rate of inert gas absorption through enhanced tissue perfusion and elevated body temperature, these exercise induced phenomena could serve to facilitate inert gas elimination during stage decompression. Thus, exercising during stage decompression after working dives may provide a means of increasing diver safety and/or reducing the duration of stage decompression.

Research on the effect of exercise during decompression has been extremely limited and the possible benefit of exercising during decompression after working dives has not been investigated. This investigation is designed to identify the effect of moderate arm and leg exercise during hyperbaric exposure and subsequent stage decompression on the risk of decompression sickness in healthy human volunteers.

Defence Relevance

The results of this research could lead to decreasing the risk of decompression sickness and decompression stress in CF divers who are required to conduct working dives in cold water, thus increasing the safety of CF diving operations.

Project Description

The role of moderate arm and leg exercise will be investigated using the standard air 45 msw/30 min decompression profile from CF Table 1. Divers will be using surface-supplied hookah and Superlite 17 helmets in the Dive Research Facility. The physical work capacity for both arm and leg exercise shall be determined in each subject before the

experimental dives begin. The exercise tasks shall be performed at the intensity equal to approximately 50% of each subject's predetermined maximal aerobic capacity. During the experimental dives, the exercise intensity will be controlled by monitoring each subject's heart rate. The scientific investigator shall assess the diver's level of exertion against the previously acquired VO2 max data and reduce or increase the work load as required. During the bottom phase of each dive, three five minute exercise periods will be performed, each followed by five minutes of sitting rest. During decompression stops, intermittent exercise periods will be conducted starting at 7 minutes on a 5 min work/5 min rest cycle. Water temperature will be maintained between 8-10 degrees C. After each dive, subjects will be monitored with the Doppler ultrasonic bubble monitor for a minimum of 2 hours after surfacing.

PROGRESS

A one-week pilot study using DCIEM divers was conducted in December 1993, with the main experimental dives being done in April, 1994. A total of 35 dives, consisting of 129 man-dives, including experimental dive subjects, standby divers, and team leaders were conducted. Experimental subjects were volunteers from the Seneca College Underwater Skills Program with supervisory and support divers from the DCIEM diving pool. Nine different combinations of exercise and inactivity during the bottom phase of the dive and during the decompression were investigated. A preliminary analysis of the Doppler-detected bubble data indicates that mild exercise during decompression appears to be more beneficial than inactive decompression. The most stressful dives in terms of large quantities of observed bubbles were the dive subjects who remained sedentary during the bottom phase and during decompression. Although some cases of decompression sickness occurred, there was little correlation with either activity or inactivity. Thus, low intensity exercise may prove to be an additional safety factor for divers required to perform vigorous work in cold water.

Productivity

Nil

PROJECTIONS

A make-up/follow-up study will be conducted in December 1994 to acquire additional data for conditions in which only limited testing could be done.

Quality Assurance Standard For Soda Lime Activity

Project Scientist:	D. Eaton
Start Date:	May 1991
Finish Date:	May 1993
Code:	DCIEM 51CD
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

The introduction into service of the Canadian Clearance Diving Apparatus (CCDA) and the Canadian Underwater Mine-countermeasures Apparatus (CUMA) created a deficiency in the diving grade soda lime quality assurance standards used by the Canadian Forces. The existing standard (D-87-003-001/SF-000 Ch 1991-01-25) was developed specifically for the needs of the CCDA's predecessors, *i.e.*, the British made Clearance Diving Breathing Apparatus (CDBA) and its successor the Diving Set, Self-Contained, Clearance Diving (DSSCCD). The soda lime quality assurance standard prescribes procedures for determining the ability of a soda lime sample to absorb carbon dioxide and sets minimum standards for accepting the sample on the basis of the test results. However, there is no data available to relate the existing standard to the CCDA/CUMA requirements. The existing CF test is very specific to one type of apparatus and it would be difficult to relate results from this test to those from other countries. Therefore, a new test method and acceptable performance standards were investigated.

The quality assurance standard is also concerned with other soda lime characteristics such as granule size distribution, dust content, friability, and volatile matter content. As a whole the standard requires re-writing to eliminate ambiguous specifications. At the same time, NATO is examining the feasibility of common test procedures for soda lime quality assurance including absorption capacity testing. The NATO requirements for soda lime are much the same as the Canadian Forces (CF), consequently, the contents of the CF and NATO standards will be very similar.

Defence Relevance

Carbon dioxide absorbent is an integral component of the CCDA/CUMA. Present quality assurance standards were designed specifically for the CDBA/DSSCCD. The CCDA/CUMA scrubber design is much more efficient than the CDBA/DSSCCD so that the present performance standards are more conservative than required. This can lead to refusal of carbon dioxide absorbent that would be suitable for CCDA/CUMA. The end result would be an eventual transfer of the cost of refusal back to the CF. A new perfor-

mance test that is closer to other NATO countries would help the interchange of equipment, in this case carbon dioxide absorbent, among the participating countries.

Project Description

The project involves the development of the equipment and procedures for testing the absorption capacity of diving grade carbon dioxide absorbent (e.g., soda lime, lithium hydroxide). The technique needs to be quick (less than 2 hours), reliable and independent of the absorbent's physical characteristics (e.g., grain size distribution, grain shape, hardness). The results of the test must be positively correlated to the results of unmanned endurance trials performed on the CCDA/CUMA carbon dioxide scrubber. That is, the test results should allow the prediction of CCDA/CUMA carbon dioxide scrubber endurance. On the other hand, the quality assurance test must be generic, that is, it must not be specific to the CCDA/CUMA.

The remaining tests in the standard will be reviewed with Directorate of Ships Engineering staff who will eventually re-write the CF specification.

Experimental Diving Unit (EDU) staff will participate in the development of the NATO standard with the view to keep the standards similar.

PROGRESS

EDU's Head, Diving Research and Development Group reviewed the second and third drafts of NATO Study 1411 - NATO Standard to Quantify the Characteristics of Carbon Dioxide (CO₂) Absorbent Material for the Diving Applications. The third draft was presented to the Underwater Diving Working Party.

Productivity:

Study 1411UD - CU/UK Study Report - Third Draft

PROJECTIONS

The fourth draft of the study report will be produced by the custodian country (United Kingdom) and circulated by 31 Dec 94 to participating countries for review. Comments on the fourth draft are expected by 28 Feb 95. EDU expects to send a representative to England in Sep 94 to attend a technical meeting on a new study, Study AAAA - Interoperability Information on CO₂ Absorbent Material used with Underwater Apparatus.

SSDS Communications Standardization

Project Scientist:	L. Ferrari
Project Officer:	Lt.(N) J.A. Frew
Start Date:	1 Apr 92
Finish Date:	31 Jul 94
Code:	DCIEM 51CD
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

Fleet Diving Units (FDU) and HMCS CORMORANT have an immediate need to standardize surface supplied diving (SSD) communications. Each field unit is using a different method to interconnect the components of the system (between the divers helmet, the umbilical and the communications box on the diving support vessel).

The resulting incompatibility between the methods created problems with:

- a. transfer of equipment between units;
- b. standard operating procedures; and
- c. operator training.

The commercial market for diving helium voice unscramblers, such as those required by the CF, is dwindling. Helle may soon cease production of helium voice unscramblers altogether. It may be prudent to initiate a project to develop a communication unit or units to meet CF diving requirements and give the CF design control over the end product.

The Radio Communications Technologies Section of the Communications Research Centre (CRC) in Ottawa approached DCIEM to develop a helium voice unscrambler. During a visit to their lab in Jan 92 they showed EDU staff some promising results from their preliminary work in this area. National Defence Headquarters (NDHQ) decided that this work was outside the scope of their project, but was not opposed to its development.

Defence Relevance

The Canadian Forces (CF) has a requirement for a standardized, SSD communication system that will provide the following:

- a. diver to surface communications;
- b. surface to diver communications;
- c. diver to diver communications; and
- d. helium speech unscrambling.

Project Description

EDU aims to analyze the existing SSD communications systems and develop a specification for a standardized SSD communications package. FDU(Atlantic) identified and effectively solved the problems with the SSD communications umbilical wiring. It remains for EDU to develop an equipment configuration which will address concerns involving the helmet and communications box umbilical interfaces.

To improve helium communications, the Chief of DCIEM decided that EDU should pursue the development of a helium voice unscrambler prototype for use in the DRF/DTF through an agreement with CRC, under CRAD-funded R&D (Project DD51CD).

Integration of all diving communications requirements into a single unit is something that has been considered for the future. Such a unit would replace existing hard wire SSDS air/helium unscrambling, through water communications, video survey system communications, and re-compression chamber communications. With success of the initial CRC helium unscrambler work further advancement of diver communications could take place.

PROGRESS

A team from EDU installed the equipment required for OPVAL S866—Surface Supplied Diving Communications Standardization, in the FDU(Pacific) SSD system in Feb 94. The EDU team briefed key FDU and Ship Repair Unit (Pacific) personnel on the OPVAL Test Plan (EDU Test Plan 08/93 Surface Supplied Diving Communications Standardization).

EDU contracted CRC to develop a helium speech unscrambler. CRC demonstrated the first helium speech unscrambler prototype during TECHVAL S850 at FDU(Atlantic) in Sep 93. The second prototype was demonstrated at DCIEM in Feb 94.

Productivity

Frew J. TECHVAL S850—Surface Supplied Diving Communications Standardization Report, Technical Memorandum HPSD 93-14, dated 16 Nov 93.

PROJECTIONS

OPVAL/S866 will take place from 25 Apr to 13 May 94 at FDU(Pacific). The aim of the OPVAL will be to evaluate the proposed communications configuration under operational conditions.

EDU will submit a final report in July 94 which will include an OPVAL report, specifications for a standardized SSD communications system and recommendations for a quality assurance programme and a diving communications package.

CRC will deliver a hardware prototype of the helium unscrambler complete with software source code by 31 Apr 94. EDU will install the equipment in the DRF communications system and tests of the prototype will be conducted during experiments scheduled for Jun 94.

Evaluation of Thermometal Neoprene for Diving Suits

Project Scientist:	D. Eaton
Project Officer:	Lt(N) J. Frew
Start Date:	Sep 1991
Finish Date:	Oct 1994
Code:	DCIEM 51CD
Effective Date:	May 26, 1994

PROJECT DETAILS

Background

The CF has used essentially the same neoprene for nearly 2 decades; however, neoprene manufacturers have made significant improvements to the products available. One of the newest and most promising is a neoprene from Yamamoto that has a fine application of either stainless-steel or titanium. In Sept 1991, DMEE 4-4 purchased two wet suits made from metal-lined neoprene on a buy-and-try project. Yamamoto claimed these suits would yield a 25% increase in thermal protection over the material currently used in CF Arctic wet suits. One suit had a titanium coating applied to its liner and the other had stainless steel. It appeared that the metal was applied to the liner of the wet suit in powder form (similar to paint). New versions of the neoprene sandwich the metal in layers.

Defence Relevance

If this material proves to have greater thermal protection than the neoprene in current use, wet suits could be made of thinner material and still provide the same thermal protection. Therefore, CF divers will not have to use as much weight to counteract the buoyancy of their garments. The garments will also be less bulky and more flexible. These changes will improve mobility in the water which will increase diver performance and safety. The research will also prepare the CF for the possible removal from the market of the traditional neoprene material.

Project Description

DMEE sent the suits to EDU for trial and evaluation to verify the manufacturers claims and to determine the suitability of this material as a replacement for the RUBATEX neoprene in current inventory. This was to be a low-priority, minimal cost project. Initial suggestions to quickly test the relative thermal protection of the new materials using divers at EDU failed. The suits were poorly sized and did not fit anyone in the EDU dive pool.

EDU decided that a more objective evaluation would be to use controlled, unmanned con-

ditions to compare the thermal conductivity of the proposed metal-lined neoprene to the neoprene in current use. A test protocol was developed to compare thermal conductivity in dry, uncompressed against wet, compressed conditions. EDU obtained sample material from the manufacturer of the metal lined suits as well as RUBATEX material from the SRU wet suit shop.

A manned evaluation of the wet-suits was also arranged by finding two divers at FDU(P) who could wear the suits. The trial will determine how the material will stand up to the clearance diver working environment and will last for one year or until the suits wear-out.

PROGRESS

The manned evaluation of the two original suits was completed in Nov 93. The results of the trial were inconclusive. The suits did not fit well compared to the subjects' CF wet suits. The neoprene used was different thicknesses, one was 4 mm while the other was 3 mm. The subjects felt the suits were colder than their CF suits but this opinion was based on a very small number of dives. The minimal use also made it impossible to conclude whether the Yamamoto neoprene is rugged enough for CF use.

EDU obtained samples of a new generation of metal dosed neoprene at the end of August 1993. This material (Yamamoto 45-LL Stainless Steel Thermometal) has yet to be evaluated using the thermal conductivity testing device.

EDU also met with Yamamoto representatives in Jan 94 (previous contact had been made through Atlan) and found that Yamamoto was producing two new versions of the metal dosed neoprene, Titanium α and SCS-metal (Super Composite Skin). The Titanium α uses nylon both sides and a titanium coat between the neoprene and nylon on the inner and outer faces of the material. SCS-metal uses titanium coated neoprene with nylon skin on one side and a very low friction composite skin on the other. The SCS provides a very slippery surface that would be valuable for wrist and neck seals; would reduce the effort, and subsequently the wear and tear that comes from donning and doffing suits; and, because of its hydrophilic nature the wet suit would feel dry each time the diver put the it on. Yamamoto also provided a list of specifications describing the different grades of their neoprene.

EDU met Oceaner in Apr 94 to examine a dry suit made from Titanium α . The Oceaner representative indicated that other manufacturers produce metal coated neoprene.

Productivity

M.B. Ducharme and Frim J. (1993) Insulative properties of two thermo-metal neoprenes. DCIEM Report 93-53.

PROJECTIONS

DMEE is considering procuring thermo-metal suits for diver training courses. DCIEM research is complete.

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (the name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Establishment sponsoring a contractor's report, or tasking agency, are entered in section 12.)

Defence and Civil Institute of Environmental Medicine
1133 Sheppard Ave. West, P.O. Box 2000
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Semi-annual project review of the Experimental Diving Unit.
Nov 1993 to Apr 1994

DESCRIPTIVE NOTES (the category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Project progress reports.

5. AUTHOR(S) (Last name, first name, middle initial. If military, show rank, e.g. Doe, Maj. John E.)

Eaton, David J.
McDougall, Scott A.

6. DOCUMENT DATE (month and year of publication of document)

June 1994

7a. NO. OF PAGES (total containing information. Include Annexes, Appendices, etc.)

44

7b. NO. OF REFS (total cited in document)

NIL

8a. PROJECT OR GRANT NO. (if appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant)

8b. CONTRACT NO. (if appropriate, the applicable number under which the document was written)

9a. ORIGINATOR'S DOCUMENT NUMBER (the official document number by which the document is identified by the originating activity. This number must be unique to this document.)

DCIEM Report No. 93

9b. OTHER DOCUMENT NO.(S) (Any other numbers which may be assigned this document either by the originator or by the sponsor)

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Progress reports for twelve of the Experimental Diving Unit's research and development projects. The reporting period covers November 1993 to April 1994 inclusive.

14. **KEYWORDS, DESCRIPTORS or IDENTIFIERS** (technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible, keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

Project Review, Underwater Diving, Decompression, Diver Heating, Contaminated Water Diving, Soda Lime, Carbon Dioxide Absorbents, Underwater Communications, Submersible Life Support Systems, Lithium Hydroxide, SCUBA Regulator Freeze-Up, Mine countermeasures Diving, Exercise, Neoprene, Wet Suits, Dry Suits, Acclimatization.